# Mushroom News

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Vol. VII No. 3 JANUARY 1959

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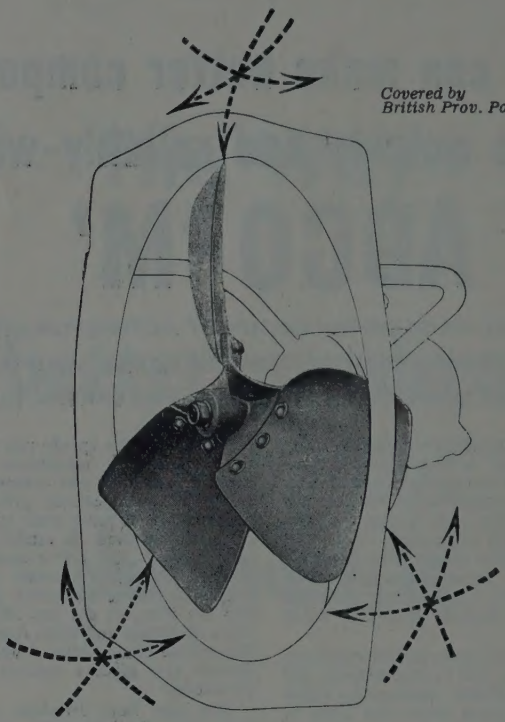

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# Mushroom News

Vol VII No. 3 JANUARY, 1959

## CONTENTS

EDITORIAL ... ... ... ... ... ... ... 41

NOTES AND NEWS ... ... ... ... ... ... 42

INTERNATIONAL CONGRESS ... ... ... ... 43

PESTS OF THE CULTIVATED MUSHROOM
No. 4. Flies, Phorid and Cecid ... ... ... ... 44

VIRUSES IN MUSHROOMS
Ctibor Blattny and Albert Pilat ... ... ... ... 50

NOTES ON LACCARIA AMETHYSTINA ... ... ... .. 56

PROFILE
Dr. Leonard Broadbent ... ... ... ... ... 57

MODERN MUSHROOM EQUIPMENT
The Chatsworth Stillage Lift. The Versatruck ... ... ... 60

### OUR FRONT COVER

Miss Alma Cogan, singing star of radio and television, with a basket of mushrooms presented to her after "Worker's Playtime" in the canteen of Messrs. A. G. Linfield Ltd., at Thakeham.

*(Photograph by courtesy of the "Worthing Herald")*

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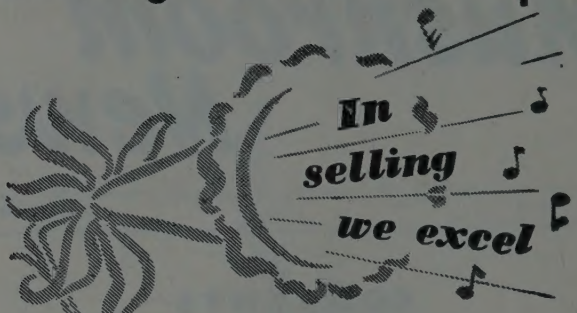
# Blowing our own trumpet

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# Mushroom News

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**WORTHING ENGLAND**

**Vol. VII No. 3** **JANUARY 1959**

**Viruses and Mushrooms**

So far as we are aware all scientific experiments to prove the existence of virus diseases in mushrooms have produced the same results as the Rothamsted experiments described in the Report of the Rothamsted Experimental Station for the year 1951 (pp. 84-85):—

'An outbreak of Mummy disease in Yorkshire presented the opportunity to study this disease which American workers have suggested may be caused by a virus. Dr. I. F. Storey provided soil and compost from affected beds and, when added to boxes immediately before fruiting, this successfully transmitted the disease. None of our experiments has given results suggesting that it is a virus disease, and some of our results suggest that it is not. Extracts from mummy mushrooms have been added to compost with spawn and with fruiting bodies, and have been inoculated to young "buttons" without reproducing the disease. Pure cultures of the fungus were established on agar media, from pileus tissue and from spores, of both normal and mummy mushrooms. Composts in 8-inch pots were successfully inoculated with these cultures, and with spawn derived from them and grown on wheat grains, but all gave normal mushrooms. Thus the disease appears not to be caused by a virus that is present within the hyphae or spores of affected fruiting bodies. The cause remains undetermined, but seems more likely to be some agent present in the soil that is not perpetuated within the mushroom tissue (F. C. Bawden and P. H. Gregory)'.

In view of the continual discussions concerning Mummy Disease, La France Disease, Brown Disease and other mysterious expressions of disapproval on the part of the cultivated mushroom and suppositions as to their virus nature, a translation of a recent paper by the Czech botanists C. Blattny and A. Pilát was thought to be of topical interest and is published as such in this issue.

As a scientific paper it seems to us, however, to carry little conviction, comparing most unfavourably with the Rothamsted publication, and advancing our knowledge of virus and mushrooms very little, if at all.

We are still of the opinion that study of the bacterial rather than the virus flora of the mushroom bed will provide the reason for many of the peculiar symptoms shown by mushrooms. Conditions conducive to development of massive bacterial populations (and these conditions may have occurred many weeks prior to the appearance of the symptoms shown by the mushroom) may start a far-reaching train of events.

One such that is known already is the correlation of massive infestations of the eelworm *Rhabditis* with preceding bacterial breeding and the subsequent deterioration of the spawn.[1] It is also highly probable that lysis (breakdown) of the mushroom hyphae may be brought about by various bacteria in a similar way to the lysis observed by Horikoshi and his colleagues[2]. This is, however, we hope, intelligent speculation and years of hard research work lie ahead before final proof appears.

[1] van Haut H.—*Nematologica* 1, 1956, No. 2 and Personal Communication.

[2] Horikoshi, K. and Sakaguchi K.—*Journ. Gen. and Appl. Microbiol.* 4, No. 1, 1958.
Horikoshi, K. and Iida S.—*Nature* 181, pp. 917-18, 1958 and Personal Communication.

# Notes and News

**Horticultural Publicity**

Mr. Stanley Swash, who is chairman of the Horticultural Marketing Advisory Council, has proposed a new scheme for a horticultural publicity fund. There should be a compulsory levy of one-third of a penny in the £ on all produce, paid by the grower and collected by the wholesaler.

To obtain the necessary powers of compulsion, legislation is required, and if the Council, backed by the horticultural industry, goes to the Government with the scheme, then it will take not less than two years to get it under way.

**Mushroom Mine**

In his recently published book "Unexploded Bomb", Major A. B. Hartley, M.B.E., reports that he has gathered mushrooms from between the lining boards of a bomb-shaft fourteen feet below ground level. The shaft had been dug to allow the removal of an unexploded bomb.

Apparently the ground had been filled and levelled fifty years before, and he suggests that mushroom spawn buried at that time had lain inert and patient until it again found itself exposed to air.

**Discoloration**

Peeled potatoes treated with a 0.5 per cent. solution of sodium metabisulphite can be stored for from twelve to fourteen days without discoloration, according to the annual report of the Low Temperature Research Station. After treatment the tubers are stored at a temperature of 37.5 degrees Fahrenheit.

**Italian Labour**

The Ministry of Labour announced in November that no more Italians could be brought into this country at the present time. The reason given was that there was now sufficient British labour to fill the vacancies.

The decision has aroused opposition in the Lea Valley, where growers complain that there is still a shortage of the right type of man, and that the new labour becoming available is too old and lacks nursery experience.

**Casing Experiments**

Growers in Berks County, Pennsylvania, are co-operating with the State University by undertaking trials to evaluate the use of Lelite as an additive to their casing soil. Lelite is an incinerated shale and its

addition to a heavy soil will improve, it is hoped, the aerability of the casing layer, and at the same time prevent panning.

Dr. Leon R. Kneebone is in charge of the trials, and explains that limited growing space at the University has necessitated asking selected growers to co-operate. Berks County was chosen because casing soils there have a greater clay content than those in the other mushroom-growing districts of Pennsylvania.

**Disaster in Belgium**

An appalling tragedy occurred on the 23rd December when sixteen mushroom workers lost their lives at Zichen-Zussen-Bolder in Belgium. They were working on underground mushroom beds when the roof collapsed.

The plant had over 150 people at work in the network of galleries that honeycomb a hill, when the collapse took place. Eye-witness reports describe how blocks of stone were hurled across a field from the entrance, and dust clouds rose hundreds of feet into the air. Rescue teams from Dutch collieries across the frontier, army engineers and firemen, worked throughout the night to rescue the trapped.

The excavations into the hill were made during the First World War, when arms and ammunition were stored there. Some of the galleries are so high and wide that lorries can be driven through them and altogether they stretch for more than ten miles.

King Baudouin watched rescue work during the night and was joined by three cabinet ministers. Over seven acres of mushroom beds were buried in the downfall.

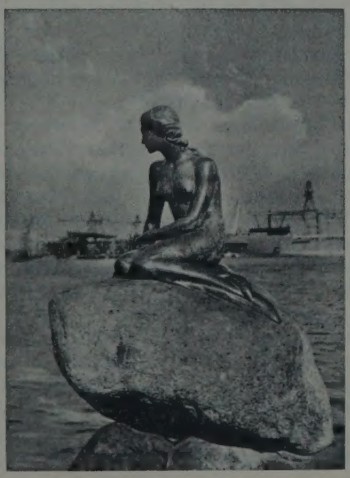
Mushroom growers everywhere will join with us in expressing sympathy for the bereaved in this disaster, which must be unprecedented in the mushroom industry.

## FOURTH INTERNATIONAL CONGRESS

### COPENHAGEN

The Fourth International Mushroom Congress will be held in Copenhagen from the 18th to the 26th July, 1959. C. Riber Rasmussen, who is Secretary-General to the Congress, states that it will have as a theme—"on a better understanding of the Cultivated Mushroom".

The Congress has a full programme of lectures by experts, discussions and demonstrations. There will be visits to mushroom farms in Denmark and Sweden, and to the Danish Mushroom Research Centre. Growers attending the Congress will also have the opportunity of visiting either the Tuborg or Carlsberg brewery, Frederiksborg Castle and the Royal Porcelain factory.



*The Little Mermaid—Copenhagen*

# PESTS OF THE CULTIVATED MUSHROOM

## No. 4—Flies, Phorid and Cecid

by

Martin D. Austin

*Continuing his series of articles on the pests of the cultivated mushroom, Martin D. Austin discusses the Phorid Fly, and deals with Cecid larvae, of which so much was heard two years ago when there were infestations on a massive scale in many widely scattered parts of the country.*

In our last note a general reference was made to those flies the larvae of which cause damage to cultivated mushrooms and, in particular, an extensive survey of the biologic and economic aspects of the Sciarid flies was given.

However, as modern mushroom growing itself is so intensive, involving a close cropping sequence with the same crop in the same buildings year after year, it is not surprising that to some extent the life-story of one pest intermingles freely with that of others.

While much of the information touching on the direct and indirect control of Sciarids is equally applicable to some other fly pests, notably Phorids, each group of pests must be considered as differing fundamentally and must therefore be dealt with individually.

1. *Flies*

(b) *Phorids.* The flies commonly known as Phorids are small and dark in colour, and in comparison with Sciarid flies the body is inclined to be stout and the wings relatively shorter. Their antennae or feelers are also quite short, and relatively inconspicuous, which serves further to distinguish Phorids from Sciarids.

As the superficial differences between Phorids and some of the very small and harmless fly species frequently associated with compost are not readily appreciated a much more certain method of determining whether Phorids are in fact causing damage is by reference to the larvae actually attacking the crop.

Of those Phorid species occuring in this country, a number have been recorded in and around mushroom farms. These species include *Megaselia nigra* which, under one name or another, has long been known as a pest of cultivated mushrooms: another and quite notorious species is the so-called Worthing Phorid Fly, scientifically known as *Megaselia halterata* and also as *M. plurispinosa.*

An idealised account of a typical Phorid life-cycle follows:—

The eggs which are very small and usually off-white are laid in a variety of situations. Generally speaking, they are laid well within

the casing media: in fact, the adult flies of some species are said to burrow down into the compost itself. Others lay their eggs on the exposed portions of cut mushroom stalks, sometimes in the spawn piece, on or nearby newly-scattered grain spawn within newly-opened spawn cartons as well as elsewhere.

*Phorid Fly—Megasalia halterata*

Each fertilised female is capable of laying from 40-60 eggs; thus, once established within a mushroom unit, populations can build up considerably.

These eggs, which normally hatch within about a week, give rise to maggots or larvae which are markedly different from those of both Sciarids and Cecids in being rather stout, while those of both Sciarids and Cecids are slender.

In colour they are uniformly whitish and lack the conspicuous black head-capsule which is such a characteristic feature of the Sciarid maggots.

Phorid larvae feed for some 7-21 days and then pupate individually in rather dirty white wedge-shaped puparia. From these the adults emerge some weeks later. Pairing follows and egg-laying takes place subsequently.

Thus, in the absence of a soundly based scheme of control, one generation of Phorids is quite rapidly followed by another. However, a considerable and sometimes confusing over-lapping of these generations occurs with the inevitable result that populations tend to get out of hand particularly in the warmer months. It is then that Phorids in their multitudes exact such a toll in commercial mushroom units: it is then also that the dire effects of a population build-up forces itself upon the attention of all those concerned with the economical growing of the crop itself.

Fortunately there are some growers who appear to have always successfully warded off this pernicious pest, in fact, so successfully that some might well be inclined to feel that we over-emphasise the importance of Phorids. Yet there are many others who have no doubt that given the right conditions these flies, through their larvae, are pests indeed.

The economic significance of their larvae or maggots lies in the fact that even when they occur in very large numbers the damage they cause is often so sudden that control measures may be initiated too late to effect economic results.

With some species the larvae are responsible for devastating damage to the mushrooms themselves, with individual "buttons" being so riddled with larval feeding-tunnels that the young "buttons" collapse.

In other instances, although the mushrooms grow to "cups" and even to "opens", an examination of the interior will reveal a number of larvae busily feeding within the stalk and even the cap. Even where but one or two maggots are within the harvested mushroom there is time enough for these hungry individuals to cause further damage before reaching somebody's kitchen!

But the "unseen" damage, that on the spawn and the developing mycelium itself, is even more considerable. Thus the presence of a

heavy larval population influences the cropping potential of a unit.

Nevertheless, as has been noted with the "Worthing Phorid", the larval damage to both the spawn and the developing mycelium can reach such proportions as to bring about a cessation of cropping itself.

When the aggregate effect is as serious as this, the whole working economy of a mushroom farm may well be thrown out of gear.

However, since it appears that some commercial mushroom beds have supported a larval and pupal population of the "Worthing Phorid" of the order of 1,000 per sq. ft. to a depth of 6 inches before the crop has been seriously affected, the presence of large numbers of flies freely moving about a unit may not necessarily mean real trouble!

Nevertheless since "to be wise in time" is often infinitely better than "being wise after the event", we suggest that the presence of even a few Phorid flies or larvae should be viewed with rather more than a modicum of suspicion.

It is interesting to recall that it has recently been reported that a species of parasitic eelworm, *Bradynema*, may attack a significant proportion —from 20% to 80%—of the female Phorids with the effect of rendering them infertile.

It also seems, according to Hussey (M.G.A. Bull. 105, p.363) that the problem confronting the mushroom grower in connection with Phorids is one of reducing egg-laying on newly spawned beds. With this is mind the search for an insecticide with some repellent action will be followed with considerable interest.

We have also to bear in mind that since to many of us there appears to be a form of resistance to certain insecticides the actual chemical control of Phorids should be achieved as quickly as is possible. It is very important to obtain the maximum controlling effect in the shortest possible time—in other words a quick, sharp knock-out blow. In this way the risk of inducing an insect's tolerance of or resistance towards one or more materials should be much reduced. Then should any evidence of recovery or resistance manifest itself the substitution of one type of chemical for another should suffice.

There is little or no doubt that, as with so many other mushroom pests, invasions of Phorids can be somewhat limited by a proper regard to hygiene within and around the mushroom cropping units. It has been suggested that these flies are attracted by the characteristic odour of the developing mycelium and they have been noticed congregating around newly opened cartons of spawn. Practical steps should therefore be taken to ensure that such an "open" invitation to invade is at least as limited as possible. The normal and practical methods of preventing the entry of actively flying species have been noted in the account of the Sciarid flies.

Direct measures to effect the control of Phorids include sprays, dusts, fumigants and the like. Excellent results have followed the experimental use of a 5% Malathion dust worked into the compost. This material, incorporated with the compost after peak-heating, at the rate of 1 lb. per ton of compost considerably reduced Phorid infestation for some weeks. Its use earlier in the composting process might well be of very considerable value. The use of a Malathion spray has also been advocated particularly against the adult fly.

*Damage done to mushrooms by larvae of the Phorid fly.*

With certain chemical materials a degree of protection to personnel is necessary with particular emphasis on protection of the face with a light mask to prevent spray droplets and vapour from affecting eyes, mouth and nose.

Since there are statutory regulations concerning this matter, growers should be aware of their responsibilities in this respect, and as there are clear instructions about the use of all such chemicals on the appropriate container, the matter need not be further discussed here.

The use of a Basudin dust for Phorid control has much to commend it; in fact it is suggested that as an integral part of pest control the beds should be examined regularly from the time of spawning onwards so that should any flies be noticed the use of the dust can be quickly started. In this way a damaging build-up in fly population can be arrested. The dust is formulated so that at the rate of 2-3 ounces per 1,000 cubic feet of air space a high degree of Phorid control is achieved. In this connection it has been noted that these and other flies are most active (and albeit most susceptible) during the day particularly in the presence of light. Further, as even a slight increase in house temperature several hours before the use of the dust has the effect of increasing the "kill" obtained, this should be borne in mind.

To ensure a more even distribution of chemicals in the form of dusts and the like, the judicious use of an electric fan is worthwhile; whilst a complete "closing" of the treated unit is an obvious necessity.

The advantages associated with the employment of a BHC dust (see MUSHROOM NEWS, VII, No. 2, p. 39) are many, not the least of which is achieved by its incorporation into the compost at its final turn. This should ensure that a fly- and larva-free compost shall reach the cropping unit: thereafter appropriate use of alternative insecticides will prevent population build-up.

These insecticides now include BHC, Nicotine, DDT as well as certain other materials: some used as sprays or dusts, others as fumigants and aerosols or smokes. These used skilfully bring Phorid control well within the bounds of an economical running of the mushroom unit and indeed must eventually (as they do) assist in bringing an achieved mushroom crop somewhere near its actual potential.

Doubtless in this age when something new is relatively quickly replaced by something better, we shall see striking developments in the chemical control of mushroom pests. With Phorid control we are probably best advised at present to alternate

the use of one material with that of another even although the continued use of one spray or what you will, is basically attractive.

Finally, in referring to Moreton's account of the 'Worthing Phorid' (The Grower: 25 June 1955) where it is suggested that as these flies are attracted to light, any windows in mushroom houses should either be sprayed weekly with 0.1% Malathion or smeared with a sticky material, we draw attention once again to the importance of not only emptying out cropped-out units as quickly as possible but to the necessity of using suitable insecticides and sterilants to reduce the carry-over of mushroom troubles.

In general it may be said that in respect of the fly pests of cultivated mushrooms an effective control measure for one should be lethal to another. Nevertheless even a slight biological difference as between one group of flies and another may well invalidate such a comfortable statement: in this connection we have only to refer to the following fly species to realise the significance of such a slight biologic shift.

I. *Flies.*

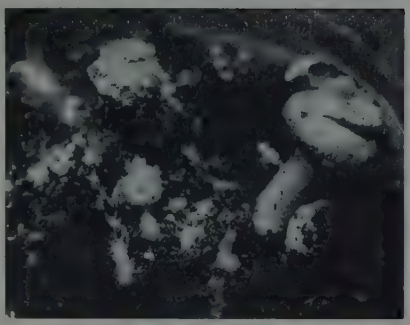
(c) *Cecids.* Much has been written about one of the very striking features associated with at least one of the Cecid pests of cultivated mushrooms, namely the occurence of paedogenetic larvae. This phenomenon is remarkable in that a large number, if not all, of the larvae or maggots themselves give rise to other larvae. Since this may continue over a period of months or even years, it will be appreciated that massive increases in the larval cecid population within a mushroom can rapidly occur. This inevitably means that the period in which a cecid community can cause serious damage is, as it were, boundless except by the natural termination of the 'life' of a particular mushroom bed. Considering Cecids generally, there are many species in which the females produce eggs, which, on hatching, give rise to the maggots or larvae. These maggots in turn, after becoming fully fed, pupate and eventually give rise to the adult stage—the Cecid flies themselves.

Since the larval stage is the effective feeding and growing stage of all flies the fact that paedogenesis occurs in at least one mushroom infesting species and its influence on the effectiveness of control measures must be borne in mind.

Typically the adult Cecids are small and slender and often quite fragile and graceful flies. A very noticeable feature is that their wings—they have but one pair—are fringed with very delicate 'hairs'. The colour varies, as between species, with the body generally more colourful than the wings.

The maggots or larvae also are slender and are inclined to be almost pointed at both the tail and the head end, although in some species these maggots are a trifle stout. Again, depending on the species concerned, the maggots may be yellowish, orange or white.

In the experience of many mushroom growers the larvae of Cecids are seldom found in very large numbers unless a mushroom bed or a number of boxes or trays are infested with other pests or, more noticeably, the cropping output of a unit is being retarded by some out-of-step condition in the bed. For instance, in conditions where the compost is over-wet or where an eelworm and/or mite species has seriously affected the cropping capa-



*Cecid larvae swarming on mushrooms (Photograph by J. E. Morton of Glasshouse Crops Research Institute).*

city heavy populations of cecid larvae are often also present.

It has been suggested that Cecid larvae are more commonly found in mushroom units now than formerly: and also that this increase is related in some way to the widespread use of peat as a casing medium. The fact that peat tends to hold more water than does soil might well be a factor favourable to the occurrence of cecids.

As to the actual physical damage caused to mushrooms by Cecid larvae, this includes a limited amount of burrowing into and feeding upon the mushroom tissues. The actual gills of the mushrooms can also be damaged.

It seems probable also that where larvae occur in such massive numbers in the compost some disruption of the mycelium in a mechanical way must also occur, and in the presence of massive larval populations it is likely that some inhibition of mycelial growth may follow. Also it is likely that where there are large larval populations in a relatively restricted area of compost, the developing mycelium may suffer from an accumulation of toxic by-products of digestion *via* the faeces of the larvae.

Since really serious trouble due to these pests is more likely when the larvae are within the beds from the time they have been laid down the importance of preventing their early entry is considerable. The cooking-out of houses after the beds have been cleared has much to commend it. There is no doubt that the controlled use of steam heat does much to eliminate Cecids from units just used: and such freedom gives the following crop a good chance of becoming really established before being susceptible to re-infestation.

Of the chemicals now generally available Basudin dust (its active ingredient is Diazinon) is known to be very efficacious against Cecid larvae and should be used in the manner as outlined under the control of Phorid flies.

Some success has also been achieved against them by the use of various formulations of Nicotine.

Nevertheless, generally speaking, the control of Cecid larvae is far from an easy matter since they are usually so well established within the compost. Where generation after generation of larvae follow each other *within* the beds themselves, the practical control problem is largely to ensure that the lethal chemical shall reach them in a sufficient dose to bring about larval mortality.

As this is not always easy, once again control is more likely to be found eventually along the lines now being explored in connection with Phorid control: namely, the discovery of a suitable and efficient repellant. Only in this way is it likely that Cecid control will be achieved and *maintained* at a high level.

# VIRUSES IN MUSH

## "The Possible Existence of Viruses in Mushro

*The existence of viruses among mushrooms has not yet been proved with certainty. Some authors believe that the Mummy Disease of Cultivated Mushrooms, causing microcephaly, could be due to viruses. Such disorders also include the infection among Laccaria amethystina, which B. Němec* (1940) *transferred by means of a filtrate to originally healthy sporophores of the same kind. The present writers think it possible that other abnormalities also might be caused by viruses. Giving the reasons for their opinion they explain the methods of proving the virus nature of these abnormalities and diseases among mushrooms.*

VIRUSES among mushrooms are as yet unknown, i.e. their presence has hitherto not been proved with certainty. There has so far been, however, no serious attempt made to do so. Nevertheless, suspicions of the virus character of some of the symptoms among mushrooms have been expressed. We could not trace the author who first suggested that some pathological symptoms among mushrooms might be caused by viruses. The first foreign experts on this subject were probably Tucker and Routien (1942). Unfortunately, we were unable to procure their treatise on "The Mummy Disease of the Cultivated Mushroom". The experiment of B. Němec (see below) was made in 1940. It seems therefore likely that he should be given priority. By the kindness of T. Bukowski (1957) we obtained some important extracts from the papers by Atkins (1949, 1955), from which we quote the following very significant passages: *Report of* 1949:

"Mummy Disease. Characteristics: The disease first becomes apparent in a limited area of the bed with a few mushrooms having stalks longer and thinner than usual, often slightly curved; the caps are small and often tilted, due it is thought to one-sided, irregular growth of the stalk causing uneven breaking of the veil. The entire mushroom is greyish and dry in appearance. On breaking the stalk, black specks are visible, resembling grub-holes. When the next flush arrives, the affected area will have extended considerably, and will spread in all directions at the rate of more than 6in. every hour. Eventually no mushrooms develop beyond pinhead size, and they become mummified, spongy and shrunken. Original Source of Infection: Not known. Prevention: No method known. Control: The disease has not been known to spread from one bed to another, and its progress can be arrested by cutting narrow trenches across the bed 6 to 8 feet in advance of visibly affected mushrooms. Description of causal organism: The causal organism is not known—which has led to the suggestion that it may be a virus, though there appears to be no evidence in support of the theory".

*Report of* 1955:

"Mummy Disease: "Crook Neck" or "Wormhole Disease" is a most serious problem with the industry in the United States, but it was not reported in Europe until 1948*.
It is believed to be introduced with the

*MAGNUS, however, discovered microcephaly — to which Mummy Disease belongs—in Europe in 1906. (Authors' remark).

# ROOMS

ns" by

Ctibor Blattný and
Albert Pilát

*gical Institute of the Czechoslovak Academy of es, and Phytopathological Dept. of the National m Botanical Dept., in Prague)*

casing soil, but failure to isolate the causal organism has led certain workers to suggest it might be a virus disease. To establish the existence of virus disease it is necessary to demonstrate the transmission of clearly recognizable symptoms from an infected mushroom or bed to a healthy one; this has been done repeatedly, but no virus has been found in the mushroom itself. The first symptoms of the disease are small, tilted caps on long, thin stalks which often lean over slightly. At a later stage the mushrooms cease to grow after reaching button size, when they turn grey or brown and become dry, spongy and mummified. If a stalk be broken from the cap, black specks resembling grub-holes can be seen. Once a bed is attacked, the disease spreads rapidly in all directions at the rate of more than 12 inches daily, but the trenching procedure will limit the extent of the damage. There is at present no cure."

The American scientists Lambert and Ayers (1953) also expressed their ideas about "mummies" among cultivated mushrooms: "We know of no disease of mushrooms that is caused by a virus, although the symptoms of one—mummy disease—suggest that it may be caused by a virus".

The eminent expert on cultivated mushrooms T. Bukowski, Warsaw, was kind enough to inform the second of the writers of this paper, that he identified mummies in cultivated

*Laccaria amethystina and L. laccata*

mushrooms in Warsaw some years ago. The stalks, he says, are thin, the caps very small and tilted at 40-90 degrees. The fruit-bodies do not putrefy, but dry up and become mummified. The lowest part of the stalk is usually considerably thickened. The disease appears usually about a month after fruit-bodies show. As soon as there were infected fruit-bodies on the bed, no more normal mushrooms grew. The disease spread from the first infected sporophore over the whole area. He added to this description a sketch from which the appearance of the sporophore and the tilting and asymmetry of the caps can be clearly recognized.

As far as our own experience goes and, according to information obtained from growers, Mummy disease has not yet been found among cultivated mushrooms in Czechoslovakia.

We believe, however, that besides this disease—which so far has not been met with in our country—there is good reason to suspect from other pathological symptoms. infections caused by virus. There is a great variety of abnormalities of shapes and colours among toadstools (for a collective survey, see mainly Ulbrich,

1926). For example the morchelloid,* tremelloid and polyporoid forms of *Agaricus campestris* (*L.*), and several cantharelloidities, bulbosities, proliferations and also some fasciations might well be originated by a virus. Also some characteristics, viz., protuberances, excrescences on fruit-bodies suggest the possibility that viruses might be involved. These occur rarely, but several authors have observed them under characteristic circumstances and have even ascribed them (without direct proof, however) to the activity of mites (Acarina) or flies (Diptera) (Ulbrich, 1939). Here particularly should be mentioned microcephaly** among white mushrooms (Magnus 1906), which doubtless is identical with the Mummy disease described above. To the microcephalies also belong, however, an abnormality observed by B. Němec, who as a result of his experiments assumes an infection by virus: it was a microcephaly of *Laccaria amethystina* (Bolt. ex Fr.) Berk. et Br. As to abnormalities in colour, albinos especially seem to demand a virological investigation. Some of these phenomena—e.g., morchelloidities—were considered to be mutations and some authors (Ulbrich, 1926) derived from their shapes phylogenetic conclusions, taking their existence as a proof of common ancestry of several groups which are today not nearly related. From the pathologico-physiological viewpoint, however, one should explain the origin of these morchelloid and other forms as being caused more as a result of the action of specific substances involved in their botanical metabolism.

There is, however, other evidence to prove a pathological rather than a genetic origin of these abnormalities, namely:—

(a) the relatively rare appearance of such abnormalities on single fruit-bodies among other healthy ones of the same kind;

(b) among cultivated mushrooms (e.g., Anonymous 1954, Patouillard 1904), these phenomena are met with sometimes in groups or in a greater portion of a single bed, while other beds, spawned with the same spawn, have normal fruit-bodies only;

(c) the appearance of all abnormal fruit-bodies in one "fairy ring", i.e., all fruit-bodies originated from the same mycelium, (Patouillard, 1922 in *Clitocybe dealbata* Fr.—cantharelloid, Pilát, 1942 in *Amanita rubescens* (Pers. ex Fr.) Gray morchelloid, where the other fairy rings under the same circumstances grew normal fruit-bodies;

(d) the appearance of these abnormal fruit-bodies under certain circumstances of environment, e.g., at greenhouse temperature, (Hennings 1898);

(e) some important cytological changes—degeneration of the nuclei—which are evidently of a pathological character (Moreau 1913).

In a number of cases—haploid forms, coralloidities, morphoses due to lack of light, etc.—pathological changes caused by viruses are certainly out of the question. On the other hand, however, it is not always easy to single out properly the individual groups of named abnormalities.

*Abnormalities are frequently named from their resemblance to other genera Thus "morchelloid", like *Morchella*, the morel, when the surface has a honeycomb-like appearance. Similarly *Tremella*, *Polyporus*, *Cantharellus*.

**Microcephaly = with a small head i.e. cap.

**Observations on Suspected Virosis** of *Laccaria amethystina* (Bolt. ex Fr.) Berk. et Br.

We should like to mention more particularly one phenomenon which can be ranked among microcephalies. It concerns *Laccaria amethystina* (Bolt. ex Fr.) Berk. et Br., a very polymorphic species. In this case the long stalk might be assumed to be owing to the sporophores growing among *Polytrichum* and being somehow forced to elongate. The finder, B. Němec, is of the opinion that it might be a case of virosis which view seems to be proved by the experiment he made. Professor Němec gave us the following account:

"I found in the autumn of 1940 on a grassy woodland path above the Propast pond on an area of ca. $1m^2$ fruit-bodies of *Laccaria amethystina* (Bolt. ex Fr.) Berk. et Br. with stunted caps. I dried six specimens of them, and I gave two later to Dr. A. Pilát for identification. The small fruit-bodies had already developed echinulate spores and the species was *Laccaria amethystina* (Bolt. ex Fr.) Berk. et Br. I took five fruit-bodies to Prague and examined two of them with the microscope. They contained recognisable strange hyphae and no bacteria (in the preparation).

"I ground three specimens and passed them through a plaster filter. Then I sprinkled a place—about 300 paces distant from the spot where I had found the *Laccaria* previously — with the diluted juice. Here a fresh *Laccaria* grew up. Next year I found several infected fruit-bodies on the original place and two on the infected spot."

On 9th August 1954 Professor Němec again found abnormal fruit-bodies of *Laccaria amethystina*, but in another place. In the two former places (the original and the "infected" one) there were no more *Laccaria*. This happened again in September 1955.

To find a possible partial explanation of this phenomenon, we considered making biometric examinations. There was, however, no possibility of measuring the entire toadstools and their caps and stalks. The measurements would not have mattered very much anyway, for we had too little of the material at hand and, besides, *Laccaria amethystina* is a very variable species. We should, however, remark that the stalk was indeed relatively high, somewhat longer than in normal *Laccaria*, and the foot a little wider. Yet the caps were considerably and abnormally smaller than usual. The diameter was at least 3-5 times smaller and also the shape was somewhat different from the normal type (as far as one can judge from dried specimens)—the edge was more bent downwards and the caps were moderately asymmetrical. We measured 500 spores of *Laccaria amethystina* each, from the Propast locality (Němec leg., VIII. 1940), then of normal fruit-bodies of the same kind from Krhanice (8. 10. 1943, leg. Pilát) and Vodnany (8. 8. 1936, leg. Herink). Further 500 spores each from the following localities: Jevany (Svrcek leg., 25. 8. 1953)—microcephalic shape, Jevany (Pouzar leg., 18. 9. 1951)—microcephalic shape, Strasice V Brdech (Kavina leg., 19. 9. 1922)—normal shape.

The statistical evaluation of the results from measuring the spores from the localities (Propast microcephalic, Vodnany normal, Khranice normal) at n=500 was worked out from the mean number, with an

average error x $\pm$ 3.sx and the assessment of the relations of the difference to the respective errors by means of the t-test. The size of the spores from all localities was divergent; the differences were statistically extremely conclusive.

We measured spores of the same position, and as their shape is almost circular, we did not take irregularities into account. Therefore only one measurement—the widest (including spines) is given. The variation curves with the relevant data are shown in the graphs and in the table. The statistical evaluation proved that the divergences are fully conclusive.

Unfortunately, there is—as yet—too little data about the larger fungi to draw important conclusions from the variation curves describing the size of the spores, such as for instance, the taxonomical conclusions for *Peronospora* and other micro-fungi. But, admitting the great variation in size among toadstools (according to other morphological statements about the same group of organisms, which are so remarkably influenced by environment) the following conclusions nevertheless result:

The variation curve is in the case of microcephaly either:

(a) completely dissimilar to the curve of normal macrocephalic mushrooms of the same kind, or

(b) very similar to the curve of the spores from normal macrocephalic mushrooms of the same kind.

As was said above—we have rather to expect in the spores from higher fungi a greater variability (until we know more of them). But it can nevertheless be assumed that with regarding microcephaly as having a genetic basis the variation curve will *always* differ from the variation curve of the spores of the macrocephalic fruit-bodies. We conclude, therefore, that microcephaly is not of genetic but of other origin.

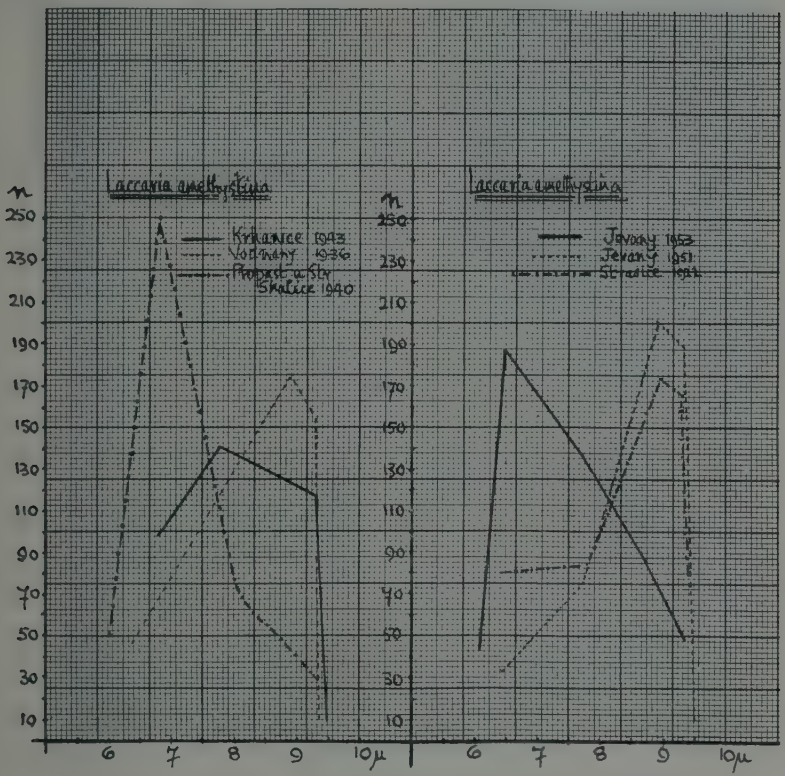
Němec's original experiment on transferring the symptoms by means of a filtrate, passed through a plaster filter, remains the most important fact. By this the transference of microcephaly was proved—although so far not incontestably.

Our thanks are due to the technical assistant of the Phytopathological Department of the Botanic Institute of the Czechoslovak Academy of Sciences, Miss Zdenka Procházková, for her collaboration on the biometrical research and the production of the graph, also to Dr. Jar. Brcák and to the assistant Mr. Zd. Polák, colleagues in the Bot. Inst. in the Czechoslov. Academy of Sciences, for their statistical arrangement of the material.

Following the findings of the scientific collaborator of the Phytopathological Dept., of the Botanic Institute of the Czechoslovak Academy of Sciences, Ing. J. Svobodová, in Ceská Lipa, during the last third of August 1957, *Laccaria amethystina* appears to be particularly susceptible to the infections described above. Miss Svobodova discovered the plant with a microcephaly and deformation of the caps near Maly Bor and near Zahrádky with microcephaly and inverted proliferation.

**Concluding Discussion**

It is as yet not fully proved that the several abnormalities among higher fungi are caused by viruses. It will certainly be very difficult to give such a proof. Firstly, because in the case of the abnormalities in question attention has hitherto usually only been given to the fruit-bodies.




Secondly, because mainly with uncultivated toadstools or those which cannot be cultivated it is impossible to establish how the abnormality is maintained and spread.

The third and main reason is that the very procedure itself of transferring viruses successfully and without any external interference is extremely difficult with fungi of a higher order.

The first obstacles occur in studying the symptoms, for we have to face quite a different category of symptoms than those which we know in flowering plants. Sprinkling with filtrates (as was done with the microcephaly on *Laccaria amethystina*) should have a positive result. A negative result, however (as with the intransferability of some viruses by mechanical methods) would not mean that there is no virosis involved. Experiments with animal transmitters for which special methods have had to be worked out, are very undeveloped. As for vegetative connexions the classic way of transmission of viruses—Němec's

treatise on Woundhealing and Transplanting of sporophore tissue in *Polyporus applanatus, lucidus, fomentarius, pubescens,* of 1935 should be of fundamental importance. This author established that the hyphae grow quickly and profusely (mainly those of the border tissue), that the wound heals quickly and that the implanted fragment is soon entirely integrated.

Regarding firmer types also implantation of small particles of tissue could be considered—in our opinion optimistically—also grafting of larger portions.

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# Note on Laccaria amethystina

*Laccaria amethystina* is a very common fungus of a lovely amethyst colour when moist, drying to a pale lilac. It is very variable both in size and shape, on an average about 1-inch across the cap and with a thin hollow, wavy stalk. It was described as *Agaricus amethystinus* by James Bolton in "An History of Fungusses growing about Halifax", 1788.

In British works it is regarded as a variety of the even more common *Laccaria laccata* which is brownish flesh-colour when moist, drying paler. Both have broad widely spaced gills and a fibrous stem, the whole fungus appearing scurfy when dry. Indeed colour seems to be the only difference between the two. The gills are decurrent as in *Clitocybe* from which *Laccaria* was segregated on account of its echinulate spores. *Laccaria laccata* is so variable that it proves a *pons asinorum* for beginners. *L. laccata* var. *amethystina* is probably equally variable but its characteristic colour makes identification easy.

J. Ramsbottom.

*Profile . . . .*

# Dr. LEONARD BROADBENT

## Division of Plant Pathology, Glasshouse Crops Research Institute

THE name of Leonard Broadbent is not as yet well-known to the mushroom industry, but it is most likely that he will play an important part in its future.

Mr. F. W. Toovey, almost immediately after being appointed Director of the Glasshouse Crops Research Institute at Rustington, publicly assured the Mushroom Growers' Association of his interest in their difficulties and outlined the general research problems on which the Institute was then engaged. In June last, a special open-day for mushroom growers was held and visitors were able to see the long-awaited new buildings just beginning to be put into use. A further step followed in September when Dr. L. Broadbent took up his appointment as Head of the Division of Plant Pathology which comprises the Departments of Mycology, Entomology and Virology, to which it is hoped will shortly be added a Department of Nematology. It is in this division that much of the mushroom research will be carried on. Obviously unless there is to be complete autonomy a hard and fast circumscription is impossible. A growing mushroom, whether healthy or diseased, provides ample scope for team work of the widest extent and it is preferable that there should be close contact with other Departments rather than try to form a self-contained unit by isolating workers from colleagues investigating problems by similar methods though on different lines. Thus, P. B. Flegg, whose work on composts and casing soils is so well known, remains in the Chemistry Department to which he was transferred from Yaxley.

Leonard Broadbent was born at Saddleworth, near Oldham, but, nevertheless, in the West Riding of Yorkshire, on March 27th, 1916. He first went to Oldham Hulme Grammar School and, when his family moved to Sheffield, to Dronfield Grammar School there. In 1934 he entered King's College, London, and, becoming interested in Zoology which he took as a make-weight subject for his Intermediate, decided to specialise in it with Botany as a subsidiary. He obtained his Honours degree in 1939, being placed in the Second Class. He had a normal youth's interest in games, particularly rugger and tennis, but he admits that the social life of the

college proved an over-riding attraction. Many north-country lads coming to London for an academic course feel its fascination, intra-and extra-mural. Saddleworth when I knew it fifty years ago, was a village nestling at the foot of the Pennines as different from the Strand as it is possible to imagine. Sheffield, except for its proximity to the beautiful Derbyshire countryside, was hardly inspiring. Be that as it may, young Broadbent entered into all sorts of college activities and, indeed, took a leading part in them. Doubtless he spent much time in organising matters for the communal good that could profitably have been given to his own affairs. In those days a second-class honours degree usually closed the door to an academic career, and teaching was the alternative. When war broke out, Broadbent immediately volunteered but was rejected for service. So—teaching it had to be, and the following year he obtained his Teacher's Diploma, London University Institute of Education.

On leaving the University (1940) he went as an Assistant Master at Lady Manners School, Bakewell. The following year he was appointed Assistant Advisory Entomologist, Agricultural Advisory Service, Midlands Province. While at Sutton Bonington he made a survey of Potato aphids, and when his results were published in 1945 he was invited to join the staff at the Rothamsted Experimental Station, as a plant pathologist, and remained there until his move to Rustington. His main research was on the epidemiology of virus diseases—potato, *Brassica*, lettuce—dealing with both the virus and the vector, the effect of insecticides and the economics of spraying. Amongst other matters was his proof that winged insects are the main vectors of potato virus and he put forward sane suggestions which if adopted by English growers, would save them an appreciable part of the £7 million they spend annually on potato "seed".

Serving on the Lawes Agricultural Trust Committee at Rothamsted, I have had the privilege of reading reports on Broadbent's work over the years, knowing of him rather than knowing him, until he began to make his mark among the large and remarkably able body of research workers there. With his alert mind and wide interests, he benefited to the full from the exceptional opportunities afforded at this historically and internationally famous research station, and gave much in return.

He is of medium height, well-built and has the toughness of a north-country dalesman, retaining much of the characteristic manner and some of the accent. He no longer plays games, but his three children will probably attend to that: his present hobbies are gardening and reading. In his student days he proved a good "mixer" and he has a way with farmers—in several series of long-term experiments he succeeded in obtaining from them a wide range of help. It is rumoured that he was selected for his present post on account of his interest in the problems of commercial growing and his ability to establish friendly relations with those engaged in it.

Rustington is fortunate in having as a principal member of its staff one who interprets the problems of Plant Pathology as anything that disturbs the even tenor of a plant's ways. It is an outlook which will help in the effort to find solutions to some of the fundamental problems underlying such disturbances in

mushrooms, and of their special growth requisites.

It is perhaps well to stress that research on mushroom cultivation falls roughly into two groups, though there is no hard and fast line between them. The one, which has so far been mostly dependent on private enterprise, can deal only with immediate issues for which a solution is required, or the modification of methods so as to take advantage of advances in theory, in technique or in technical manipulations. The other, which may be called long-term research, is not immediately concerned with practical results but is devised to explore basic facts, to find out, as it were, how and why the wheels go round. This, as I see it, is the kind of research we need, and shall get from Rustington, though there will also be the more immediately applicable results such as have been published in the past by Miss Gandy, Mr. Flegg and Dr. Hussey. Practical growers may be inclined to complain that such research is leading nowhere. Chrysanthemum growers doubtless thought the research on the effect of light on flowering was mere waste of time and money until it resulted in all-the-year-round production.

Visitors last June saw the prototype of a constant-growth cabinet or culture chamber, of which there are to be eight—and wondered how such things could be. They are designed to permit of more basic study of growth and pests and diseases

Perhaps, as a former civil servant, I may say a helpful word. Any grower can be certain that everything divulged to the staff at Rustington remains confidential—and any questions put by them are to get at scientific facts, not to learn business details.

Dr. Broadbent is a live wire with wide contacts both at home and abroad. To take up the details of his academic career:—he gained his Ph.D. in 1948 and his D.Sc. in 1957. He was awarded a W. H. Kellogg fellowship in 1955 and spent four months in a tour of research stations in the U.S.A. and Canada. He is very active in scientific circles, being Hon. Sec. of the Biological Council, Hon. Gen. Sec. of the Association of Applied Biologists and a member of numerous Councils and Committees. With the general overlooking of the Director, and the immediate interest of Dr. Broadbent it looks as if, at long last, mushroom research will take its proper place in horticulture in this country.

JOHN RAMSBOTTOM

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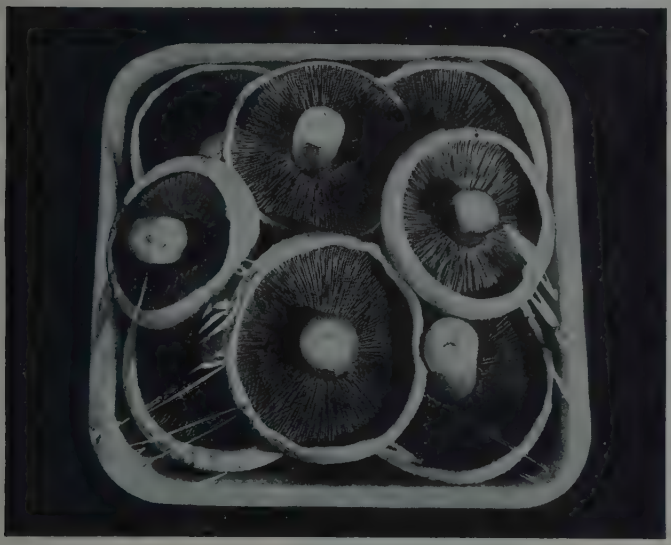

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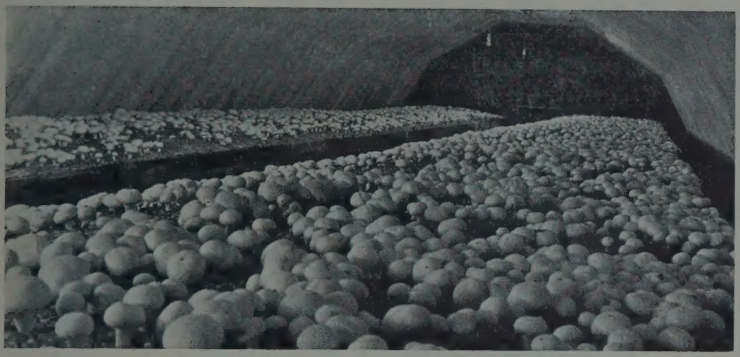

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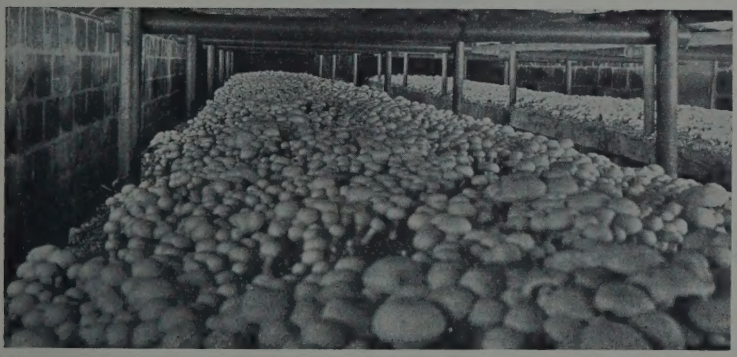

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